Fort St. John
Forest District

Vegetation Resources Inventory
Strategic Inventory Plan

MINISTRY OF FORESTS
RESOURCES INVENTORY BRANCH
JANUARY 13, 1999

Executive Summary

This Strategic Inventory Plan (SIP) outlines the Vegetation Resources Inventory (VRI) activities and products needed to address the forest management issues identified by stakeholders in the Fort St. John Forest District. The Ministry of Forests (MOF) Resources Inventory Branch prepared this VRI SIP (VSIP) following consultative meetings involving all key forest inventory stakeholders and in consideration of relevant documentation. The VSIP provides a general strategic direction for implementing the provincial VRI and management inventory activities in the Fort St. John Forest District.

The stakeholders in the District can also use this VSIP to prepare coordinated VRI Project Implementation Plans (VPIPs). A VPIP is a working document that details the specific operational activities associated with implementing and documenting the inventory activities identified in the VSIP. The VPIP identifies the project geographic areas, priorities, plot location coordination, inventory costs by year, and roles and responsibilities for implementation. The VPIP may be for ground sampling or photo-interpretation projects.

The stakeholders in the Fort St. John Forest District identified the following VRI activities and products, as defined by the BC Resources Inventory Committee (RIC) standards:

a) Undertake a photo-interpreted estimates inventory to provide spatial data to support timber, ecosystem, habitat, riparian, and other mapping applications that provide information for land management.

b) Undertake timber emphasis ground sampling in the Fort St. John TSA to provide spatial data, statistically valid timber volumes, and other tree attributes to support the timber supply review in this management unit.

c) Undertake photo interpretation/ground sampling in mixed-species stands with spruce understory in the District, to provide spatial data to support identification of these stands for wildlife and timber management.

d) Develop more reliable factors to account for decay in pure deciduous and mixed-deciduous stands using the VRI net volume adjustment factor (NVAF) sampling methodology.

e) Conduct timber emphasis ground sampling in dense pine stands to provide spatial data to support the development of a management strategy for these stands.

f) Conduct provincial VRI ground sampling over the entire District, to provide baseline spatial and non-spatial data, for use in provincial inventory reporting, monitoring, and research.

The identified VRI activities in the District include both photo-interpretation and ground sampling. Where the photo-interpreted estimates inventory is recent, the existing polygon timber inventory should be translated to VRI format and additional VRI (non-timber) attributes added through photo-estimation of the existing photos. New photos should be used in areas with old inventories (more than 10 years old). Ground sampling should be conducted over the entire District landbase to support the provincial VRI and the identified sub-units. The sample sizes for this ground sampling are listed in the following table.

Land Type	Number of sample clusters – All VRI measurements	Number of sample clusters – Tree measurements only	Total number of sample clusters
Vegetated Treed	70	80	150
Remaining Area (Non-Vegetated, Vegetated Non-Treed)	85	-	85
SubTotal	*155*	*80*	*235*
NVAF sampling			*75 trees*
WPV sampling			*10 polygons*
Sub-units			
Fort St. John TSA		180	180
NVAF		-	75 trees
Mixed-species stands		50	50
Dense pine stands		150	150
Deciduous stand NVAF		-	*75 trees*

Implemented separately, the total cost of the provincial VRI and the management inventories ground sampling would be approximately $1,680,500. The total cost of obtaining photo-interpreted estimates for two-thirds of the District would be approximately $4,200,000, assuming a retrofit of 120 mapsheets (at $1.00/ha) and new photo interpretation of 95 mapsheets (at $2.00/ha). The data for the remaining one-third of the District (125 mapsheets, mostly flat agricultural area and muskeg) would be rolled-over from the Forest inventory Planning (FIP) file. Efficiencies can be gained by combining the inventory activities within the District and among other districts.

The stakeholders, lead by the District, will develop criteria for setting priorities among the activities and products. Funding for the inventory activities is not discussed in this VSIP. The Region should incorporate the VSIP and VPIPs in submissions to Forest Renewal BC (FRBC) or other coordinating agency for funding.

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1. INTRODUCTION

1.1 Background

This Strategic Inventory Plan (SIP) outlines the Vegetation Resources Inventory (VRI) activities and products needed to address the forest management issues identified by stakeholders in the Fort St. John Forest District. The Ministry of Forests (MOF) Resources Inventory Branch prepared this VRI SIP (VSIP) following consultative meetings involving all key forest inventory stakeholders and in consideration of relevant documentation. The VSIP provides a general strategic direction for implementing the provincial VRI and management inventory activities in the Fort St. John Forest District.

1.1 The Vegetation Resources Inventory

The VRI is an improved vegetation inventory process for assessing the quantity and quality of BC's timber and other vegetation resources. The VRI addresses the inventory design-related issues raised by the Forest Resources Commission in its 1991 report *The Future of Our Forests*. The VRI was designed by inventory specialists from government, industry, and academia, and has been approved by the BC Resources Inventory Committee (RIC). The RIC objectives are to develop a common set of standards and procedures for Provincial resources inventories.

The VRI process consists of procedures for:

1. *Photo-Interpreted Estimates*
   - Delineating and classifying vegetated polygons using the BC Landcover Classification Scheme (BCLCS).
   - Making initial estimates of the vegetation attributes within polygons.

2. *Ground Sampling*
   - Sample planning.
   - Locating and establishing sample plots.
   - Collecting data related to trees; site, soils, plants, and succession; coarse woody debris; and range resources.
   - Net Volume Adjustment Factor (NVAF) sampling.
   - Within Polygon Variation (WPV) sampling.

These VRI procedures and other terms in this report are defined further in the Glossary (Appendix A).

The VRI procedures provide spatial and non-spatial products for resource-specific management interpretations, provincial inventory reporting, monitoring, and research. The

management interpretations include timber management, ecosystem management, and habitat management. The spatial products include:

- Line work – polygon boundaries.
- Vegetation Inventory File Database – adjusted and unadjusted polygon labels and estimates.

The non-spatial products include:

- Raw Database – Raw data from field cards.
- Summary Database – Compiled data and inventory statistics.
- NVAF Database – NVAF stem analysis data (raw, compiled, and statistics).
- WPV Database – WPV polygon data (raw, compiled, and statistics).

1.2 VRI Overriding Principles

The new VRI procedures are now being implemented throughout the province. The implementation is based on the following guiding principles:

- To integrate the provincial inventory activities, including the provincial VRI, management inventories, and the National Forest Inventory.
- To implement inventory projects to satisfy business needs as defined in the VSIP and VPIP documents. The VSIP identifies the forest management issues in a district and the VRI activities and products required to address those issues; the VPIPs identify the priorities and spatial location of VRI activities (Section 2).
- To develop spatial VRI products in a structured way (e.g., implement the photo interpretation activities in blocks such as mapsheets or watersheds, and estimate all the attributes listed in the photo interpretation manual).
- To implement inventory projects following approved VRI implementation standards as defined in the MOF Resources Inventory Branch 1998 report *Vegetation Resources Inventory Implementation Strategy to Integrate Management, Provincial, and National Inventories*.

Implementing the identified inventories using VRI standards addresses the issues raised by the Forest Resources Commission's 1991 report *The Future of Our Forests*. The issues raised relate to the inadequacy of forest inventories in the province, and included lack of statements of precision on the inventory, inadequate information on non-timber vegetation, and the narrow focus on commercial timber volume and the operable landbase.

1.2 Document Objectives

This VSIP is for the implementation of the provincial VRI and management inventories in the Fort St. John Forest District in the Prince George Forest Region. It was developed through consultation with various stakeholders in the Fort St. John Forest District, including the Ministry of Forests (Branch, Region, and District staff), Ministry of

Environment Lands and Parks (MELP), and the licensees, who identified inventory needs and priorities.

This VSIP:

- defines the strategy for the provincial VRI in Fort St. John Forest District;
- defines the management inventory products;
- identifies the inventory activities required to produce the desired inventory products; and
- outlines a proposed implementation strategy.

This VSIP was reviewed and discussed by the MOF and other stakeholders in the District during a conference call held on November 30, 1998. The current document presents the revised VSIP, which requires the approval of the MOF District Manager, Regional Manager, Director of the Resources Inventory Branch, and other stakeholders.

2. INVENTORY PLANNING

1.3 Planning

This VSIP was developed following the MOF VRI planning process (items 3 & 4 below), which is an important component of the overall VRI process (items 3, 4, & 5) and linked/related activities (items 1, 2, & 6). The overall VRI process and linked activities include (Figure 1; Appendix B):

1. Forest management decision processes (land integration planning)
2. Identification of forest management issues
3. VRI Strategic planning (VSIP)
4. VRI District operational planning (VPIPs)
5. Implementation, including development and maintenance of procedures and standards:
    a) Management inventories
    b) District-wide VRI
    c) Database management
6. Data interpretation, including ecosystem and habitat mapping

The VRI planning process involves developing strategic plans (VSIP) and project plans (VPIP) that identify resource-specific management issues, desired inventory products, and priorities. A VSIP outlines the VRI products needed to address the identified forest management issues, and provides a general strategic direction for implementing the provincial VRI and management inventory activities in the District.

The stakeholders in the District can use this VSIP to prepare coordinated VRI Project Implementation Plans (VPIPs). The VPIPs are working documents that detail the specific operational activities associated with implementing and documenting the inventory activities identified in the VSIP. The VPIP may be for ground sampling or photo interpretation projects, and identifies the project geographic areas, priorities, plot location coordination, inventory costs by year, and roles and responsibilities for implementation.

The VSIP and VPIPs provide the framework for coordinating the implementation of the provincial VRI over the District, and management inventories over priority areas. The VSIP and VPIPs seek to ensure that VRI products address important issues in priority areas, and support resource-specific management interpretations that address forest management issues. This planning process defines the baseline inventory product needs, ensures that the right baseline products are selected to meet a range of applications, and achieves efficiencies in the delivery of the desired inventory products. Coordinated inventory planning also maximizes the value of the inventory data produced over issue areas by ensuring that the VRI products are useful for addressing more than one resource issue.

1.4 Funding

The stakeholders, lead by the District, develop criteria for setting priorities among the VRI activities and products identified in the VSIP. Funding for these inventory activities, or follow-up resource-specific management interpretations, is not discussed in the VSIP since funding mechanisms vary from time to time. Presently, funding is a regional responsibility that should be addressed at the VRI planning meetings. The Region should consider the VSIP and VPIPs in submissions to Forest Renewal BC (FRBC) or other coordinating agency for funding.

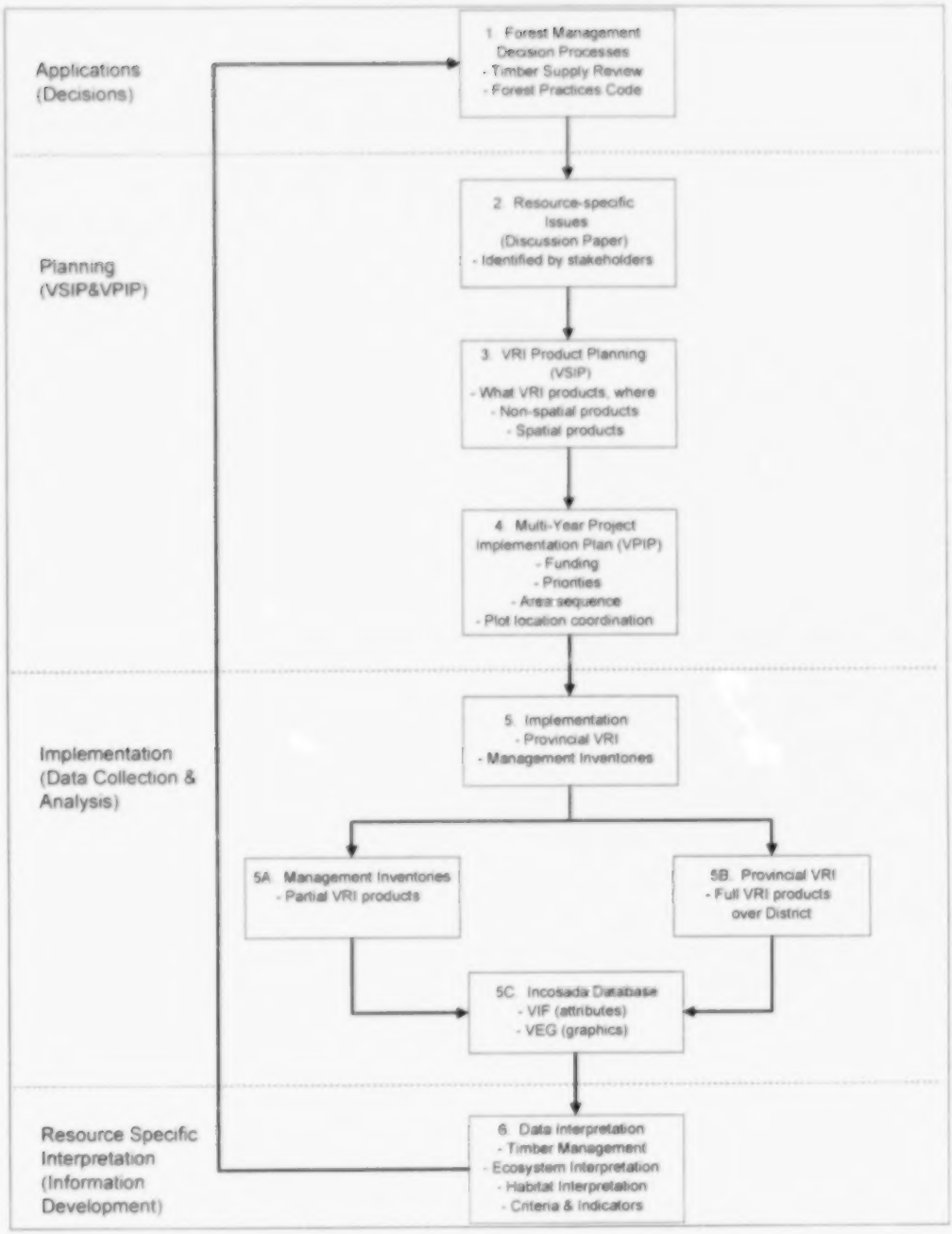

Figure 1. The Vegetation Resources Inventory process.

3. BUSINESS CONSIDERATIONS

3.1 Forest Management Issues

Priority forest management issues were identified in the recent timber supply review in the Fort St. John TSA (Table 1). An assessment of the potential use of the VRI photo-interpreted estimates and the ground sampling is also indicated for some of these management issues. The table does not show the relative importance of these various issues. For example, a statistically accurate timber volume estimate may carry more weight than all other issues combined. In this case, the contribution of the VRI ground sampling will be quite significant.

Table 1. Forest management issues and the use of the VRI to address issues in the Fort St. John Forest District.

Issue[1]	VRI		Remarks
	Photo-Interpreted Estimates	Ground Sampling	
1. Slope and terrain hazard mapping for ESAs: complete prior to next analysis.	Needed	Needed	Estimation phase data could be used by interpreters of terrain stability. Ground sampling will have a partial impact on slope stability as the ground sampling data will provide a check and act as an audit of the maps.
2. Pre-inventory analysis, re-inventory: determine deficiencies in existing inventory.	Not Needed	Not Needed	A draft report has been completed (April 1997).
3. Utilization standards for deciduous: re-examine prior to next analysis.	Not Needed	Not Needed	
4. Decay, waste, and breakage: develop better allowances, especially for deciduous stands.	Not Needed	Needed	Ground sampling (NVAF sampling) will provide information on decay and waste. Estimates of breakage are not available.

[1] BC Ministry of Forests, Timber Supply Branch. 1996. *Forest Management Issues Identified Through the AAC Determination Process, TSA/TFL Timber Supply Reviews: 1992-1996.* 31 December 1996. Victoria, BC. P.114. And BC Ministry of Forests, Fort St. John TSA Timber Supply Review Data Package. July 1997.

Issue[1]	VRI		Remarks
	Photo-Interpreted Estimates	Ground Sampling	
5. Unsalvaged losses: monitor salvaged and unsalvaged losses and develop estimates for deciduous stands.	Not Needed	Not Needed	
6. Unsalvaged losses from fire: examine prior to next analysis.	Not Needed	Not Needed	
7. Variability of inventory audit: determine sources of error.	Not Needed	Needed	Overall mature inventory was over-stated by about 19%. Inventory audit results in the operable landbase need to be confirmed.
8. Roads, trails, and landings: monitor/reassess prior to next analysis.	Not Needed	Needed	Studies suggest that ground sample data may provide estimates for net downs for existing roads, trails and landings.
9. LRMP: assess timber supply implications in next analysis.	Not Needed	Not Needed	
10. Regeneration delay and maintenance: solutions required.	Not Needed	Not Needed	
11. Recreation mapping and ESAs: complete new mapping and account for in future analyses.	Needed	Needed	The collection of ecological, soil, and slope stability data during ground sampling will assist in the confirmation of ESAs.
12. Alternative silviculture systems: incorporate into future analysis if systems become operational.	Needed	Needed	Improved inventory: estimation phase will provide layer information (vertical complexity) which can aid in assessing the impact of alternative silviculture systems on timber supply.

Issue[1]	VRI		Remarks
	Photo-Interpreted Estimates	Ground Sampling	
13. Riparian, biodiversity, FENs, old growth, mature forest cover: clarify timber supply impacts and interactions.	Needed	Needed	Photo-interpreted estimates should improve polygon delineation, provide better age class, stand structure, and vegetation attributes, and information on soil moisture and nutrient regime to enhance the interpretation of FENs, riparian areas, seral stage and natural disturbance types interpretation. Ground sampling will provide overall district totals for coarse woody debris, stumps, potential wildlife trees, and plant lists for species diversity. The reliability of the estimates obtained for these attributes will need to be evaluated based on natural disturbance types before comparisons to the biodiversity guidelines. There is a risk that precise estimates will not be obtained for these attributes. The data will be used to identify supplemental sampling needs. A new photo-interpreted estimates inventory is particularly important because of the age of the inventory in the District.
14. Protect important ecosystems and habitats for red and blue listed species, key ungulates, and other regionally significant species.	Needed	Needed	The VRI is needed to support mapping important ecosystems and habitats for red and blue listed species, key ungulate ranges, and other regionally significant species. The photo-interpreted estimates inventory provides a spatial inventory with attributes needed to support ecosystem and habitat mapping. Wildlife habitat mapping can not be accomplished without spatial data; these products are highly relevant to forestry planning. Ground sampling provides plant lists, forage production, and shrub transects, which can be used to support ecosystem and habitat mapping.

Issue[1]	VRI		Remarks
	Photo-Interpreted Estimates	Ground Sampling	
15. Landscape-level biodiversity: incorporate all guidelines, boundaries, objectives, and prescriptions, including designated landscape units and biodiversity emphases.	Needed	Needed	The VRI can provide supporting data, e.g., potential re-definition of "old growth" based on VRI stand structure and age attributes.
16. Undertake ecosystem and habitat mapping and important areas analysis to assess and protect important ecosystems and habitats for red and blue listed species, key ungulates, and other regionally significant species.	Needed	Needed	VRI attributes are utilized in ecosystem and habitat mapping. This mapping needs to be supported after the VRI products are produced in order to address the identified forest management issues.
17. Develop management practices to protect habitat. Work with Ministry of Environment to undertake appropriate forest management practices on important habitats and ecosystems.	Needed	Needed	Rationale for this statement is included in all of the above items. In particular, wildlife habitat spatial information provides a needed inventory-based approach for identifying critical areas and habitat features for wildlife and for use by forest managers to protect important ecosystems and habitats.

3.1 VRI Activities and Products

The VRI activities and products that are needed to meet the forest management issues outlined in Table 1, and those identified at the Stakeholders meeting, are listed below:

a) Undertake a photo-interpreted estimates inventory over the District to provide spatial data to support provincial and sub-unit timber inventories, habitat mapping, ecosystem mapping, riparian mapping, and other applications.

b) Undertake timber emphasis ground sampling in the Fort St. John TSA to provide spatial data, statistically valid timber volumes, and other tree attributes to support the timber supply review in this management unit.

c) Undertake photo-interpretation/ground sampling in mixed-species stands with spruce understory in the District, to provide spatial data to support identification of these stands for wildlife and timber management.

d) Develop more reliable factors to account for decay in pure deciduous and mixed-deciduous stands using the VRI net volume adjustment factor (NVAF) sampling methodology.

e) Conduct timber emphasis ground sampling in dense pine stands to provide spatial data to support for the development of a management strategy for these stands.

f) Conduct provincial VRI ground sampling over the entire District, to provide baseline spatial and non-spatial data, for use in provincial inventory reporting, monitoring, and research.

Development of land management information from these identified VRI products includes (but is not limited to) the following post-inventory activities (not discussed in this VSIP):

- Timber supply analysis to support AAC determination.
- Ecosystem and habitat mapping to address ecosystem and habitat forest management issues.
- Seral stage mapping to provide estimates of coarse woody debris and other requirements described in the biodiversity guidelines (Forest Practices Code).
- Monitor standing inventory, decay, and taper, to provide a level of comfort to users on the accuracy of net volume.
- Collect change and trend data at the provincial level for reporting on the indicators of sustainable forest management, as defined by the Canadian Council of Forest Ministers (CCFM).

Note that the following information needs identified by the stakeholders are not addressed directly using the VRI procedures in this VSIP:

- Stagnation of pine stands is not accounted for in the growth models.
- Density (number of stems/ha) in openings may generally be over-stated; may be role for Forest Practices Branch.
- Area depletions due to seismic activity and well site activity; role of Resources Inventory and Timber Supply Branches.
- Base map information is inaccurate.
- OGSI - potential site index for spruce, pine, and aspen; may be role of Research Branch.
- Succession in mixed-species stands - growth and yield issue; role of Research Branch.

These needs could be addressed through other processes such as research. The next section outlines the inventory plans for the identified VRI activities.

4. INVENTORY PLAN

4.1 Overview

This section outlines plans for inventory activities needed to develop specific VRI products. The VRI activities include photo-interpreted estimates and ground sampling. The ground sampling may be at the district level (provincial VRI) or sub-unit level (management inventories):

- *Provincial VRI* involves ground sampling to provide ground sample plots database for all attributes over an entire Forest District. The photo-interpreted estimates database may use the retrofitted FIP or new photo-interpreted estimates. The ground sample plots data are combined (through statistical analysis) with the photo-interpreted estimates to provide a spatial database at the district level.
- *Management (sub-unit) Inventories* involve ground sampling using selected components of the VRI procedures, to produce VRI databases to address one or more resource-specific management issues (timber, ecosystem, habitat, etc.). The photo-interpreted estimates database may use the retrofitted FIP or new photo-interpreted estimates. The ground sample plots data are combined (through statistical analysis) with the photo-interpreted estimates to provide a spatial database at the sub-unit level. Management inventories are coordinated as much as possible to produce VRI products with multiple resource applications.

The VRI baseline products can be used in further analyses, sometimes in conjunction with data from additional sources, to produce Resource-Specific Information (RSI) needed to address forest management issues. RSI may include information for timber supply review, habitat management, and ecosystem management to address resource-specific management issues. The VRI-based products are used in VRI ecosystem and habitat mapping. The VRI-EM is an ecosystem map consisting of VRI polygons with estimated site series labels in the same format as Terrestrial Ecosystem Mapping (ecosystem, modifiers, and structural stage). The VRI-HM products are habitat maps for species at risk, ungulates, or species of management concern, such as grizzly bear.

4.2 Photo-Interpreted Estimates Inventory

4.2.1 Objective

The objective of this inventory is to improve the polygon delineation and estimation in the Fort St. John Forest District, especially in areas where specific management issues occur. The VRI product is a spatial database consisting of unadjusted photo-interpreted estimates. Ground sampling to check and adjust the photo-interpreted estimates is discussed as a separate process (Section 0).

4.2.2 Target Area

The target area for the photo-interpretation is the Fort St. John Forest District. The District and other stakeholders should identify priority strata and geographic areas, and develop a photo-interpretation schedule and options (Section 4.2.4) for the District. In setting priorities, the District should consider operating areas, areas with aerial photo coverage, management issues, and important landscape units.

4.2.3 Target Attributes

The target attributes for this inventory are all the attributes listed on the VRI photo-interpreted estimates attribute form. All attributes should be interpreted to the VRI photo-interpreted estimates standards.

4.2.4 Options

The following two options for photo-interpreted estimates inventory were considered:[2]

Option 1 -Retrofit

The retrofit process is used to incorporate the new standards for VRI delineation and estimation into the existing inventory. The process involves limited photo estimation and delineation using the existing document photos for the area. The assumption is that the current inventory is good and the goal is to fill in the gaps between the old and new standards. The intent is also to convert the existing database to a full VRI database by collecting required additional data.

The retrofit methodology has the following features:

- Field calibration to address the missing attributes and upgrading of existing attribute estimations.
- There is no new delineation in what was traditionally referred to as the "productive, forested landbase," since the standards for delineation in the VRI have not changed significantly.
- The interpreter reviews existing attribute estimates, and notes any significant errors or interpretation differences will be noted and corrected.
- Empty fields in the database will be populated by returning to the original document photos, other appropriate photography, or ortho photography to interpret the attributes.

There are opportunities to include additional features to the retrofit process depending on business needs.

Option 2 - New Photo Estimation

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[2] Vegetation Resources Inventory Photo Estimation Retrofit Procedures. 1998. Version 1.0. MOF Resources Inventory Branch, Victoria, BC (Laurence Bowdig).

New photo estimation is used to incorporate the new standards for VRI delineation and estimation into an area. It involves the completion of new delineation and polygon estimates for the entire landbase, using the most current photography. The latest VRI standards would be used for all steps in the process. This is an expensive and time consuming project and should only be used in those cases where a VPIP indicates that there is a serious problem with the existing inventory. New photo estimation may also be applicable to Timber Supply Areas (such as some portions of the Fort St. John TSA) that have not had a traditional re-inventory in the last 10 years. These inventories are typically 25-35 years old and were not delineated or classified to current standards.

The District may consider Option 1 for the areas that were recently re-inventoried. This option involves a retrofit including estimation of additional VRI attributes and re-delineation and estimation in the non-forest areas using the recent photos. New photo estimation (Option 2) will be considered in other priority areas with old photography. The District will also explore recent technologies, such as "Softcopy" (digital photogrammetry), for photo estimation.

4.2.5 Implementation

A VPIP for the photo interpreted estimates inventory should be developed following the guidelines outlined in the MOF document *Vegetation Resources Inventory Guidelines for Preparing a Project Implementation Plan for Photo Interpretation*. Preparing a VPIP will involve identifying what needs to be improved (attributes or delineation), where, and how. This will involve:

1. **Identifying the needs**. Refer to the Forest Management Issues (Section 3.1) and the VRI Activities and Products (Section 3.2).
2. **Identifying priority areas within the District**. Develop and apply criteria for ranking areas based on management needs, and define project implementation units (e.g., landscape units, mapsheets, supply blocks).
3. **Reviewing the existing inventory.** This involves a qualitative and quantitative evaluation of the attributes, delineation, and line transfer; an assessment of calibration data sources; and a review of existing photos, maps, and technology. This inventory review may be waived in the Fort St. John District since it is obvious that the inventory is very old in many areas.

The photo-interpreted estimates project could be implemented as follows:[3]

1. Define target population and objectives.
2. Assemble existing information, including PIA (pre-inventory assessment) documents, TRIM bases, photos, and updated overlays.
3. Prepare work plan.

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[3] *Photo-Interpretation (Phase I) Project Management Guidelines*. May 1997. Ministry of Forests, Resources Inventory Branch, Victoria, BC. (Contact: Bob Krahn).

4. Seek contractor to do the work.
5. Arrange for training (March to May; Forestry Continuing Studies Network).
6. Conduct fieldwork, which may include field checks/calibration preferably using air calls (May to August).
7. Conduct the photo-interpretation (September to January).
8. Digitize, check plots, and complete final quality assurance (September to April).
9. Prepare photo-interpreted estimates database and project report.

4.3 Provincial VRI Ground Sampling

4.3.1 Overview

The provincial VRI provides baseline spatial and non-spatial databases for the entire Forest District. The provincial VRI ground sampling activities include ground sampling, Net Volume Adjustment Factor (NVAF) sampling, and Within Polygon Variation (WPV) sampling.

When implemented, the provincial VRI ground sampling would provide:

1. A basis for calculating unbiased overall averages and totals for timber and non-timber vegetation resources for the entire landbase in the District. Provision of this information addresses the concerns expressed by the Forest Resources Commission in its 1991 report *The Future of Our Forests*.[4]
2. The initial conditions and locations for measuring changes and trends in the indicators of sustainable forest management, at the provincial or district level.[5] The changes and trends can be used to provide a province-wide statement of sustainability of our forest practices that would be based on an inventory with a statistically valid approach. This monitoring information can be used to counter misinformation about BC's forestry practices, to protect BC forest products markets, and to address public environmental concerns. This information was not available in previous provincial inventories, as there was no valid monitoring protocol.
3. Baseline VRI data to develop ecosystem and habitat mapping to address ecosystem and habitat management issues in forest land management.
4. Baseline data to confirm district biodiversity guidelines, non-forest classification, and site index-BEC correlations.

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[4] The Forest Resources Commission concerns included a lack of statements of precision of the inventory; inadequate information on non-timber vegetation; lack of reliable estimates of growth rates and stand-specific volumes; and the narrow focus on commercial timber volume and the timber harvesting landbase.

[5] Criteria and indicators of sustainable forest management were defined by the Canadian Council of Forest Ministers (CCFM) in their 1995 report *Defining Sustainable Forest Management. A Canadian Approach to Criteria and Indicators* (Natural Resources Canada, Canadian Forest Service, Ottawa, Ontario, 22 pages).

5. Additional information for non-timber resources (e.g., plant lists) by indicating where more intensive sampling could improve estimates for specific plants (e.g., medicinal plants) and other botanical products.
6. The VRI plot locations that can be used to measure a variety of other resources (e.g., range), special projects, and management inventories. The plot locations are established in an unbiased way and are re-locatable to allow re-visits.

4.3.2 Landbase

The Fort St. John Forest District is located in the northeastern interior of the province, and includes the Fort St. John TSA and private land. The TSA covers about 4.7 million ha of which 24%, or about 1.1 million hectares, comprise the long-term timber harvesting landbase.

1.1.1 Photo-Interpreted Estimates

Implementing the provincial VRI ground sampling in the Fort St. John Forest District requires use of the spatial database described in Section 4.2. This can be accomplished by translating existing timber information, and by adding the required VRI attributes using photo estimation of existing or new photos, particularly the non-timber attributes. The retrofitted/new database would then be used to select sample locations for ground sampling.

1.1.2 Ground Sampling

Ground sampling provides the statistical rigor for estimating overall totals and averages for timber and non-timber vegetation resources (e.g., medicinal plants and other botanical forest products) in the District. The total number of VRI sample clusters will aim to achieve a sampling error of ±10% (95% probability) for net timber volume in the vegetated treed portion of the District and allow for calculation of sampling errors for other VRI attributes. Information will be collected on all attributes, but the variability of net volume will be used to set the sample size for the VRI.

The number of samples required to achieve the sampling error standard is a function of the variation of net volume within the inventory unit, estimated by the coefficient of variation (CV%). The CV used to estimate the total number of plots to achieve a sampling error of ±10% for net volume was assumed to be 60%.[6] To achieve the VRI standard at a reasonable cost, two types of VRI plots should be used:

- Full VRI sample clusters, where the full suite of information (timber, coarse woody debris, range, and ecology) is collected.
- Timber emphasis plots (TEPs), where only tree information is collected.

The sample sizes required to implement the provincial VRI are summarized in Table 2.

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[6] No inventory audit has been conducted in this unit.

Table 2. Estimated sample size required to implement the provincial VRI in the Fort St. John Forest District.

Land Type	Number of sample clusters – ALL VRI measurements	Number of sample clusters – Tree measurements only	Total number of sample clusters
Vegetated Treed	70	80	150
Remaining Area (Non-Vegetated; Vegetated Non-Treed)[7]	85	-	85
Total	*155*	*80*	*235*
NVAF sampling			*75 trees*
WPV sampling			*10 polygons*

A sampling error standard is necessary to provide a basis for determining sample size in inventories. In the VRI, the allowable sampling error standard is set at ±10% for net volume at the district level; however, this standard does not apply to other attributes in the inventory.

The total number of full VRI samples (70) will be adequate to achieve a sampling error of ±15% in the vegetated treed landbase. Timber emphasis plots (80) are then used to reduce the sampling error in the vegetated treed landbase to ±10% (the standard for net volume). In the remaining area (non-treed and non-vegetated) of the unit, the number of full VRI samples established (85) will be the ratio of the remaining area to the vegetated treed area multiplied by the number of VRI samples required to achieve a sampling error of ±15% in the vegetated treed landbase.

Implementing the two types of samples (full VRI and TEPs) minimizes the number of full VRI plots required, and will result in savings of time and money.

4.3.3 NVAF and WPV Sampling

NVAF and WPV sampling is required to complete the provincial VRI. NVAF sampling provides factors to adjust net tree volume estimated from net factoring and taper equations. The adjustment accounts for hidden decay and possible taper equation bias. NVAF sampling involves detailed stem analysis of sample trees, calculation of actual net volume, and calculation of the ratio between actual net volume and estimated net volume (where estimate net volume is obtained from net factoring and taper equations).

The WPV sampling provides information to estimate the individual polygon error, assessed as the difference between the adjusted polygon value and the "true" value for that polygon based on intensive sampling of sample polygons.

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[7] We assumed that the Vegetated Treed landbase constitutes about 45% of the District landbase. The sample size in the Remaining Area is proportional to its area relative to that in the vegetated treed. For example, if the vegetated treed portion was 20% of the landbase, then the sample size in the Remaining Area would be 80/20*70 = 280 plots; the suggested number of plots in the Vegetated Treed portion does not change.

As shown in Table 2, a total of 75 sample trees are required for NVAF sampling (selected from 15 treed polygons and 1 non-treed polygon), and at least 10 sample polygons are required for WPV sampling.

4.3.4 Statistical Analysis

Statistical analysis is the process of adjusting the estimates from the photo-interpreted estimates using the ground sampling observations. The purposes of the analysis are to obtain overall averages and totals for the District that are statistically unbiased, and to adjust the existing or new photo-interpreted estimates information to obtain individual polygon values.

Statistical analysis includes two steps:

1. Statistical estimation of overall values. These values include totals and averages for continuous attributes, and error matrices for categorical variables, for the District.
2. Statistical adjustment, which is the process of assigning values to individual polygons such that their total (or error matrix) for the District matches that obtained in Step 1.

4.3.5 Implementation

To achieve the provincial VRI objectives, the sampling could be implemented over the entire District in a two-step process, or in parts. The two-step process could be done as follows: Step 1 is to install approximately 100 sample clusters in the first field season over the entire District; Step 2 is to install the remaining sample clusters in the second field season. The sampling locations will be selected systematically from the sorted list of potential sampling points. This list will include all polygons in the District and will be sorted by non-vegetated/vegetated and then land type, leading tree species, age, and site index.

Sampling in the first year will provide experience to refine the process for the second field season, and information to calculate precisely the remaining number of samples required to meet the precision target of ±10% for net volume in the treed portion of the District. The sampling in the first year will also provide data to check the inventory volume in the mature stands (60 years+) in the operable landbase, thus removing the need for a separate inventory audit.

An estimated total of 235 sample clusters will be assumed for planning, training, and other logistic considerations. Matching unavailable sites and sub-sampling of sample clusters with difficult access should be anticipated and planned for, as these activities will increase inventory costs.

The implementation process could proceed as follows:

1. Assemble all polygons within the District into one list; check to ensure no areas are missing or double counted.
2. Sort the polygon list according to the criteria: BC Land Cover Classification code, estimated leading tree species, age, and site index.

3. Select potential sampling points from the sorted list, as described in the MOF Resources Inventory Branch document *Vegetation Resources Inventory: Preparing a Sampling Plan for Ground Sampling.*
4. Systematically select the provincial VRI samples.
5. Systematically select the polygons for the WPV sampling from the list of provincial VRI samples.
6. Systematically select the 16 NVAF sample points (15 treed and 1 non-treed whether or not volume is indicated) from the provincial VRI ground samples.
7. Begin planning for field sampling.
8. Prepare a field sampling plan that includes sample cluster batches to ensure an unbiased sample is attained at the end of the first field season. Identify NVAF sample points and ensure they are field sampled early in the field season.
9. Locate and measure ground sample clusters.
10. Monitor quality assurance of field data and procedures during field sampling. Arrange for 'audit quality cruisers' to sample auxiliary plots of NVAF samples.
11. Compile the data in the fall and winter of the first year. This will include computing averages of timber volume, basal area, and regression of photo-estimated volume to ground-sample volume and the associated standard error of the regression.
12. Prepare NVAF tree sampling matrix. Begin NVAF stem analysis.
13. Prepare for the second step during the winter. This will include calculation of the CV based on the standard error of the regression. The remaining number of samples required to achieve the stated desired precision can then be accurately determined using standard procedures.
14. Prepare the remaining samples.
15. Locate and measure remaining ground sample clusters in the second field season. Complete stem analysis of the NVAF sample trees. Complete WPV sampling.
16. Compile all data, complete the statistical adjustments, and load final inventory results into the provincial VRI database.

A VPIP for the ground sampling should be developed following the guidelines outlined in the MOF document *Vegetation Resources Inventory Guidelines for Preparing a Project Implementation Plan for Ground Sampling.*

4.4 Management Inventories

4.4.1 Overview

Management inventories produce spatial or non-spatial data to address one or more resource-specific management issues (timber supply analysis, ecosystem, and habitat

management). They can also be used to increase the precision of the provincial VRI. Management inventories involve ground-sampling activities, with sample locations being selected from existing or new photo-interpreted data sources. The inventory units (sub-units) for management inventories vary and are defined based on business needs.

Management inventories are the responsibility of the stakeholders such as the TFL licensees or the Forest Districts. However, the MOF Resources Inventory Branch requires the TFL holders or Districts to prepare a VPIP, which includes a sampling plan, for MOF approval.

Three sub-units were identified for ground sampling in the Fort St. John Forest District to address the inventory issues raised by the stakeholders, listed below (some of these sub-units may overlap).

1. A sub-unit consisting of the TSA to provide statistically valid timber, decay, and waste estimates to support the TSR.
2. A sub-unit consisting of mixed-species stands with spruce understory in the District to provide spatial data to support identification of these stands for wildlife and timber management.
3. A sub-unit consisting of the dense pine stands in the District to improve the inventory (timber, piece size, merchantability, and site productivity estimates) of these forest types.
4. A sub-unit consisting of the deciduous stands in the District to provide estimates of decay factors to be used to net down timber volume.

4.4.2 TSA Timber Inventory

Objective

The objective of this ground sampling is to provide statistically valid timber volume and site index estimates in the Fort St. John TSA for timber supply analysis. The sampling should target a sampling error of ±10% (95% probability) for net timber volume in the timber harvesting landbase (THLB) in the TSA.

Target Population

The target population for this management inventory is the vegetated treed portion of the TSA landbase.

Sampling Unit

The sampling will be based on *Timber Emphasis Plots* (TEPs). These TEPs can use the same five-point cluster configuration as the VRI; however, measurements should be restricted to tree attributes only. These attributes are contained in VRI Card Types 8, 10, and 11, which must all be completed. Measurements of other vegetation characteristics taken on VRI plots should not be taken in these TEPs. However, as with the VRI plots,

these TEPs provide a sampling framework for any additional sampling that may be required in the future.

Sample Selection

The samples should be selected systematically from a sorted list of the polygons in the TSA. This list will include all vegetated polygons in the management unit sorted according to defined criteria. Alternatively, the samples may be selected from the same list of potential sampling points as used in the provincial VRI ground-sampling inventory.

Sample Size

An estimated total of 150 sample clusters in the THLB is suggested for planning, training, and other logistic considerations. This sample size should provide net timber volume estimate in the THLB with a sampling error of $\pm$10% (95% probability) assuming a CV of 60%. Approximately 30 plots are recommended in the non-THLB. Thus the total sample size in the TSA is 180. If the provincial VRI has been completed with 55 clusters sampled, then only 95 extra plots are needed in the THLB and none in the non-THLB.

Supporting Activities

Supporting activities include NVAF and WPV sampling. NVAF sampling is strongly recommended in this timber emphasis inventory if the provincial VRI ground sampling is not completed first. Otherwise, the NVAFs from the provincial VRI can be applied to this sub-unit. The purpose of NVAF sampling is to improve estimates of tree net volume from net factoring and to quantify decay and waste estimates, especially for deciduous stands. WPV sampling is also needed to provide information for expressing the total management inventory error and the accuracy of individual polygon estimates.

Implementation

This timber inventory should be coordinated with the photo-interpreted estimates inventory (Section 3). The ground sampling in the TSA should be implemented in a two-step process, similar to the VRI ground sampling at the district level. The inventory should be implemented in two steps as follows:

- Step 1 should install a small batch of sample clusters (e.g., 40) over the target population (80% in the THLB, and 20% in the remaining areas) measuring *only* the tree attributes. This should occur in the first field season (or first half a field season) over the entire sub-unit.
- Step 2 should install the remaining plots in the second field season (or the second half of a field season), if needed.

A VPIP for the ground sampling should be developed following the guidelines outlined in the MOF document *Vegetation Resources Inventory Guidelines for preparing a Project Implementation Plan for Ground Sampling.*

4.4.3 Dense Pine Inventory

Objective

The objective of this ground sampling is to provide statistically valid timber volume and piece size estimates in the Fort St. John TSA for timber supply analysis. The sampling should target a sampling error of ±10% (95% probability) for net timber volume in the timber harvesting landbase (THLB) in the dense pine stands in the TSA.

Target Population

The target population for this management inventory is the dense pine stands in the vegetated treed portion of the TSA landbase.

Sampling Unit

The sampling will be based on *Timber Emphasis Plots* (TEPs). These TEPs can use the same five-point cluster configuration as the VRI; however, measurements should be restricted to tree attributes only. These attributes are contained in VRI Card Types 8, 10, and 11, which must all be completed. Measurements of other vegetation characteristics taken on VRI plots are optional in these TEPs. However, as with the VRI plots, these TEPs provide a sampling framework for any additional sampling that may be required in the future.

Sample Selection

The samples should be selected systematically from a sorted list of the polygons in the TSA. This list will include all dense pine polygons in the District sorted according to defined criteria. Alternatively, the samples may be selected from the same list of potential sampling points as used in the provincial VRI ground-sampling inventory.

Sample Size

An estimated total of 150 sample clusters in the THLB is suggested for planning, training, and other logistic considerations. This sample size should provide net timber volume estimate in the dense pine stands with a sampling error of ±10% (95% probability) assuming a CV of 60%.

Supporting Activities

Supporting activities include NVAF and WPV sampling. The NVAF is strongly recommended in this inventory, to improve estimates of tree net volume from net factoring and to quantify taper equation bias.

Implementation

This timber inventory should be coordinated with the photo-interpreted estimates inventory (Section 4.2). The ground sampling in the dense pine stands should be implemented in a two-step process, similar to the VRI ground sampling at the district level. The inventory should be implemented in two steps as follows:

- Step 1 should install a small batch of sample clusters (e.g., 40) over the target population (80% in the THLB, and 20% in the remaining areas) measuring *only* the tree attributes. This should occur in the first field season (or first half a field season) over the entire sub-unit.
- Step 2 should install the remaining plots in the second field season (or the second half of a field season), if needed.

A VPIP for the ground sampling should be developed following the guidelines outlined in the MOF document *Vegetation Resources Inventory Guidelines for preparing a Project Implementation Plan for Ground Sampling.*

4.4.4 Identification of Mixed-Species Stands with Spruce Understory

Objective

The objective of this management inventory is to improve the spatial information for the mixed-species stands with spruce understory in the District. This information would help to better identify these stands in the database. This objective requires improvements to the photo-interpreted estimates in these stands, followed by limited ground sampling to check these estimates. The photo-interpretation activities can be carried out as outlined in Section 4.2; the following sections describe the ground sampling activities.

Target Population

The target population is all potential mixed-species stands with spruce understory in the District. The mixed-species stands include mixtures of spruce, aspen, and pine.

Sampling Unit

We recommend that ground sampling for this inventory be based on *Timber Emphasis Plots* (TEPs). These TEPs can use the same five-point cluster configuration as the VRI however, measurements should be restricted to tree attributes only, with possible enhancements for vertical structure, stem distribution, and merchantable volume by diameter classes. This sampling should include call grading and net factoring. Many of these attributes are contained in VRI Card Types 8 to 11. Measurements of other vegetation characteristics taken on VRI plots are optional in these TEP plots. However, as with the VRI plots, these TEPs provide a sampling framework for any additional sampling that may be required in the future.

Sample Selection

All the potential mixed-species polygons in the District should be identified in the database, and assembled into a sorted list. The polygon list should be sorted using attributes including inventory type group. Sample polygons should then be selected systematically from the list by accumulating the estimated total volumes. This will result in polygons being selected with probability proportional to estimated volume. This sorting and systematic selection ensures a uniform distribution of sample polygons over the volume range.

Sample Size

An estimated total of 50 sampling points are suggested for planning, training, and other logistic considerations. This sample size is generally adequate for checking (audit) purposes.

Implementation

We recommend that the photo-interpreted estimates inventory is completed first, followed by ground sampling. The ground sampling in this inventory can be implemented in a two-step process similar to the provincial VRI ground sampling as follows: Step 1 will install a large number of sample clusters (e.g., 30) measuring *only some* tree attributes. This will occur in the first half of the field season over the entire sub-unit. Step 2 will install additional plots in the second half of the field season.

A VPIP for the ground sampling should be developed following the guidelines outlined in the MOF document *Vegetation Resources Inventory Guidelines for Preparing a Project Implementation Plan for Ground Sampling.*

4.4.5 Estimating Decay in Deciduous Stands

Objective

Decay in deciduous stands in the District will be estimated using Net Volume Adjustment Factor (NVAF) sampling. The objective of NVAF sampling is to improve estimates of tree net volume. This is accomplished using stem analysis to provide local estimates of decay and tree taper. The NVAF is based on the actual net volume of felled trees.

Target Population

The target population includes all pure- and mixed-deciduous stands in the District.

Sampling Unit

The NVAF sampling unit is the tree. The attributes of interest are actual merchantable volume per tree and actual percent of sound wood of the merchantable volume.

Sample Selection

The sample selection is a two step process: first, select a sample of polygons to be cruised to generate a population of trees, and second, select a sample of trees from the generated population of trees.

All the potential deciduous polygons in the District should be identified in the database, and assembled into a sorted list. Sample polygons should then be selected systematically from the list by accumulating the estimated total volumes. This will result in polygons being selected with probability proportional to estimated volume. This sorting and systematic selection ensures a uniform distribution of sample polygons over the volume range.

Sample trees are selected with varying (but known) selection probabilities from the cells of a 3-dimentional matrix defined by four tree diameter (dbh) classes, six severity groups, and two access classes. This matrix is populated with tree data from the sampled clusters.

Sample Size

The MOF Resources Inventory Branch recommends a total of 75 sample trees for NVAF stem analysis selected from 15 polygons. About 80% of the polygons should be selected from the THLB and 10% from the remaining area.

Implementation

This project can be implemented following the procedures outlined in the MOF 1998 draft report *Net Volume Adjustment Factor Sampling Standards and Procedures*. This project could be combined with the TSA timber inventory project. In this case, the number of NVAF samples would be enhanced in the deciduous portions of the TSA.

5. IMPLEMENTATION STRATEGY

5.1 Priorities

The stakeholders identified the following implementation priorities:

1. Photo-interpreted estimates inventory.
2. Identification of mixed-species stands with spruce understory.
3. NVAF sampling in deciduous to check decay estimates.
4. Dense pine inventory.
5. Timber emphasis ground sampling in the TSA.
6. Provincial VRI ground sampling inventory.

The District, Region, and the licensees will discuss these priorities further. The District will lead this initiative.

5.2 Project Implementation Plans

The stakeholders should develop detailed multi-year Vegetation Project Implementation Plans (VPIPs) based on this VRI Strategic Implementation Plan (VSIP) for submission to FRBC or other coordinating agency for funding. The District and Region will coordinate this effort. The VPIPs will identify inventory activities, priority geographic areas, costs by year, and roles and responsibilities for implementation. The VPIPs will also define the relationship of this work to other FRBC-related (or other agency) initiatives in the Region.

5.3 Scheduling

The ground samples that are established to meet the management inventory objectives can also meet the provincial VRI objectives providing that these multi-purpose plots are identified in advance. Therefore, provincial VRI plots will be identified prior to identifying the management inventory ground plots. Some of these coincident plots will be used for both the provincial VRI and the management inventory. Additional management inventory samples will be established to meet management inventory objectives. This integrated approach, using one set of samples to address multiple inventory needs, will result in minimum implementation costs.

There may be a need to enhance the multi-purpose plots for non-timber attributes within the sub-unit depending on the implementation strategy chosen. The inventory strategy is therefore to implement the photo-interpretation first followed by ground sampling for management inventories as and when needed. The provincial VRI in the District would be implemented in parts (e.g., landscape units, supply blocks) within a defined time frame. Within each part, the provincial VRI plots may be installed before, during, or after the management inventories. The provincial VRI ground sampling in the District could be achieved as follows:

1. Plan the provincial VRI for the District.
2. Select a large pool (e.g., 10,000) of potential sampling points for the entire District.
3. Select both the polygons and the plot locations inside those polygons for the entire District.
4. Indicate the plot locations on large scale maps and enter them into the GIS system. This will allow any group considering sampling for management inventories to identify the plot clusters within the geographic area where they are considering this work. They may also wish to include adjacent plot clusters close to their own area or within a particular mapsheet or landscape unit.
5. Select the number of plots required for the provincial VRI plots and the additional plots needed for the management inventory.
6. Complete plots within the respective parts (landscape units, mapsheets, etc.) whenever convenient. This information can be combined at a later date with the remaining plot locations in other parts. This will provide VRI plot data for subsequent analysis.
7. Analyze the partial data to provide VRI spatial database.
8. Eventually, combine the data from the management inventories (using stratified sampling methods) and produce a complete inventory for the District. This should not span more than four years.

1.5 Costs

Estimated costs for the ground sampling inventory activities proposed in this VSIP are given in Tables 3 and 4. Implemented separately, the total cost of the provincial VRI and the management inventories ground sampling would be approximately $1,680,500. The

total cost of obtaining photo-interpreted estimates for two-thirds of the District would be approximately $4,200,000, assuming a retrofit of 120 mapsheets (at $1.00/ha) and new photo interpretation on 95 mapsheets (at $2.00/ha). The data for the remaining area (one-third of the District, mostly flat agricultural area and muskeg) would be rolled-over from the Forest inventory Planning (FIP) file.

Combining the inventory objectives through a common implementation strategy will result in savings. Given the multiple sub-units within the Fort St. John Forest District, and the overlapping areas of those sub-units, it is difficult to estimate the magnitude of savings. Combining inventories across districts (e.g., mixed-species stands inventory in Fort Nelson and Fort St. John) would result in additional savings.

Table 3. Estimated costs for the provincial VRI in Fort St. John Forest District.

VRI Tool	No. Samples	Est. Cost/Sample	Total
Full Measure VRI Plots	155	$3,000	$465,000
Timber Emphasis Plots	80	$2,000	$160,000
NVAF (trees)	75	$600	$45,000
WPV	10	$3,000	$30,000
Quality assurance (10% field costs)			$70,000
Statistical analysis			$5,000
Total			*$775,000*

Table 4. Estimated costs for the management inventories in the Fort St. John Forest District.

Management inventory	No. Samples	Est. Cost/Sample	Total
Deciduous stands decay sampling	75 trees	$600	$45,000
Mixed-species stands inventory	50	$2,000	$100,000
Dense pine stands inventory	150	$2,000	$300,000
Timber inventory in TSA	180	$2,000	$360,000
Quality assurance (10% of field cost)			$80,500
Statistical analysis ($5,000/project)			$20,000
Total			*$905,500*

5.4 Monitoring

The Ministry of Forests, Resources Inventory Branch is responsible for monitoring this VRI Strategic Inventory Plan.

6.

7. APPROVAL/SIGNING

I have read and concur with the Fort St. John Forest District VRI Strategic Inventory Plan, dated Jan 13, 1999. It is understood that this is an agreement-in-principle and does not commit the signatories to completing the inventory activities outlined within the plan. Modifications to this plan or more detailed plans need to be reviewed and approved by the signatories.

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District Manager
Fort St. John Forest District

_____

Regional Manager
Prince George Forest Region

_____

Director
Resources Inventory Branch

_____

Canadian Forest Products Ltd. (TFL 48)

Appendix A – Glossary of Terms

Ground Sampling

Ground sampling is the field measurement of timber, ecology, range, and/or coarse woody debris values at one or more locations within each sample polygon. The sample polygons are selected proportional to their area from a sorted list. To accommodate the wide variety of resources, various types and sizes of sampling units (e.g., fixed and variable plots, transects) are used to make the measurements.

Inventory Unit

An inventory unit is the target population from which the samples are chosen. For the provincial VRI, the inventory unit is the Forest District, which includes the timber harvesting landbase, parks, recreational areas, private, and federal lands. For management inventories, the inventory unit is a subset of the provincial VRI inventory unit that focuses on a geographic area or specific attribute set, depending upon the sampling objectives.

Landcover Classification

The BC Landcover Classification Scheme (BCLCS) was designed specifically to meet the requirements of the VRI, in addition to providing general information useful for "global vegetation accounting" and "integrated resource management." The BCLCS is hierarchical and reflects the current state of the landcover (e.g., presence or absence of vegetation, type and density of vegetation) and such fixed characteristics as landscape position (i.e., wetland, upland, alpine). There are two main classes of polygons: Vegetated and Non-Vegetated.

Management VRI

Management VRI are specialized inventories that provide more detailed information required for specific resource management, i.e., day-to-day forest management. One or more VRI sampling procedures may be used for management inventories. Management inventories may focus on specific resource types (timber, range, ecology), geographic areas (e.g., landscape unit, TFL), attribute sets (e.g., Douglas-fir leading stands, age class 4+). They may use one or more of the following tools (e.g., photo-interpreted estimates, ground sampling, NVAF sampling).

National Forest Inventory (NFI)

The NFI provides information on Canada's resources across all provinces and allows the Federal Government a consistent framework for reporting on Canada's inventory. The inventory unit for the NFI is the entire country, although it is implemented province-by-province.

Net Volume Adjustment Factor (NVAF) Sampling

NVAF sampling provides factors to adjust net tree volume estimated from net factoring and taper equations. The adjustment accounts for hidden decay and possible taper equation bias. NVAF sampling involves detailed stem analysis of sample trees, calculation of actual net volume, and calculation of the ratio between actual net volume and estimated net volume (where estimate net volume is obtained from net factoring and taper equations).

Photo-Interpreted Estimates

Photo-interpreted estimates inventory involves the subjective delineation of polygons and the photo estimation of attributes for all polygons in an inventory unit. Medium scale aerial photographs (1:15,000) are most often used in the photo-interpreted estimates inventory. However, if the existing photo-based inventory is acceptable, the database can be translated into VRI format and upgraded to include the additional VRI attributes.

Post-Stratification

Post-stratification involves the division of an inventory unit into mutually exclusive sub-populations (strata) *after* ground sampling has been completed. Samples that fall in each post-stratum are analyzed separately and the results are applied to the corresponding population post-strata to improve the precision of the inventory's overall averages and totals.

Pre-Stratification

Pre-stratification involves the division of an inventory unit into mutually exclusive sub-populations (strata) *before* ground sampling to provide estimates for specific areas, or to increase the confidence in the overall estimates by considering the special characteristics of each stratum.

Provincial VRI

The provincial VRI provides baseline data for provincial inventory reporting, monitoring, and research. All of the sampling procedures from the VRI toolbox are used for this inventory at the Forest District level. The databases generated from each District

inventory will be compiled to create the provincial VRI database. The provincial VRI has also been referred to in the past as the District VRI.

Resource-Specific Interpretations

Resource-Specific Interpretations (RSI) use the RIC standard VRI baseline data products (provincial VRI or management inventory), in combination with other data sets and analysis (outside of that required to produce VRI), to produce information to address specific-resource management issues (e.g., TSR review, important ecosystems, important habitats). These interpretations include ecosystem interpretations and habitat interpretations.

Retrofit

Retrofitting is the process of translating and upgrading an existing photo-based inventory to VRI standards. If the polygon linework and attributes are of acceptable quality, the existing FIP (Forest Inventory Planning) databases are translated to VIF (Vegetation Inventory Files) databases and the additional attributes required by the VRI are re-estimated from the aerial photographs.

Sample Size

The sample size for an inventory is the minimum number of ground samples to be established in an inventory unit to meet the target precision.

Statistical Analysis

Statistical analysis is the process of adjusting the values of the photo-interpreted estimates variables using the ground sampling observations. For each sampled polygon, the ground observations are compared to the photo-estimated values to develop an adjustment factor. This factor is then applied to all polygons in the photo-interpreted estimates database to produce the final adjusted database.

Sub-unit

The term sub-unit describes the inventory unit of a management inventory (i.e., the management inventory target population is a subset of the provincial VRI inventory unit). A sub-unit may be defined by a specific geographic area (e.g., operable landbase) or stand type (e.g., problem forest types) within the Forest District.

Target Precision

Target precision expresses the amount of variation in key attributes (e.g., timber volume) desired in the final results. The target precision, usually expressed as the coefficient of variation (CV), is used to calculate the minimum sample size for subsequent ground sampling.

Vegetation Resources Inventory (VRI)

The VRI is an improved vegetation inventory process for assessing the quantity and quality of BC's vegetation resources. The VRI process is designed to include a flexible set of sampling procedures for collecting vegetation resource information. The VRI is essentially a toolbox of procedures, which include:

- *Photo-interpreted estimates*: the delineation of polygons from aerial photography and the estimation of resource attributes.
- *Ground sampling*: the establishment of plot clusters in selected polygons to measure timber, ecological, and/or range attributes.
- *NVAF Sampling*: Stem analysis sampling of individual trees for net volume adjustment.
- *WPV Sampling*: Intensive sampling of selected polygons to determine the error between the estimated attribute values and the "true" attribute values.
- *Statistical Adjustment*: the adjustment of the photo-interpreted estimates for all polygons in an inventory unit or management unit using the values measured during ground sampling.

The VRI can be deployed over the entire province (provincial VRI) measuring timber and non-timber resources, or over a large management unit (management VRI) measuring selected resources in specific portions of the landbase. The VRI sampling process produces spatial and non-spatial databases that can be used in multiple resource management applications including timber, ecosystem, and wildlife habitat management.

Within Polygon Variation (WPV) Sampling

WPV sampling provides information for expressing the true individual polygon error, assessed as the difference between the adjusted polygon value and the "true" value for that polygon. The "true" value for the polygon is an estimate derived from a small sample of polygons that are intensively sampled on the ground.

Appendix B – VRI & Post VRI Components, Steps, Roles, and Responsibilities

The VRI is undertaken in the context of business needs, and the need for baseline vegetation inventory data. VRI and post-VRI information is developed to address issues identified in the planning processes. Many components are involved: 1) developing VRI baseline data products (as defined by RIC standards), and 2) developing VRI-based information products (e.g., maps for timber, ecosystems, habitat, etc.) to address the issues (as defined by RIC or Ministry standards).

The objective of this Appendix is to provide an overview and identification of all the components, their sequence, and tentative participant roles for both VRI and post-VRI information development.[8]

These components include:

VRI

a) Development of procedures and standards to undertake the VRI

b) VRI strategic planning

c) VRI District operational planning

d) Implementation of provincial VRI, district-wide

e) Implementation of management VRI, sub-district

Post-VRI

f) Implementation of management inventories

g) Ecosystem and habitat mapping (information development)

h) Land integration planning

Each of these components, and the responsible and participating/supporting agencies, are summarized in Table 5. Note that the responsible and participating/supporting agencies will vary among Regions and among projects, depending on funding scenarios and workloads of the various agencies.

[8] The first draft of this Appendix was prepared by Ron Kot, MELP.

Table 5. Overview of VRI components, steps, and example of roles and responsibilities.

Inventory Component	Responsible Agency	Participating/ Supporting Agencies
VRI		
A. Production of VRI Procedures and Standards		
1) Photo interpretation	MOF	MELP
2) Ground sampling	MOF	MELP
3) Quality Assurance	MOF	MELP
4) Net Volume Adjustment factor (NVAF) sampling	MOF	
5) Within Polygon Variation (WPV) sampling	MOF	
6) Data and warehouse standards and quality control procedures	MOF	
7) VRI Change Management Process	MOF	
B. VRI District-level Strategic Planning		
Development of VSIP	MOF (RIB) leads	Stakeholders: Industry, MOF, MELP, other agencies,
C. VRI Operational Planning		
1) Development of VPIPs	MOF (District) approves, industry/proponent (could be MOF) prepares	Stakeholders: Industry, MOF, MELP, other agencies
2) Funding Responsibility & Lead Proponent		
- TFLs	Licensee	
- TSA	MOF	
3) Submission to FRBC or other funding agency.	Lead Proponent	MOF, other stakeholders
D. "Provincial VRI" District-wide Inventories		
1) VRI Implementation	MOF (Region)	
2) VRI Data Warehouse (Data products "Custodianship")	MOF (RIB)	
E. "Management VRI" Sub-district Inventories		
1) VRI Inventory Implementation		
-TFLs	Licensee	
-TSAs	MOF	MELP and other agencies
2) VRI Data Warehouse (Data products "Custodianship")	MOF/Licensee	
	All products to MOF RIB data warehouse	

Inventory Component	Responsible Agency	Participating/ Supporting Agencies
POST - VRI		
F. Resource-specific Information Development		
1) Timber Information Development	MOF/Licensee (TFL)	
a) methods and standards	MOF	
b) Inventory needs id and planning – Strategic	id in VRI Plan	
c) Inventory needs id and planning – Operational	id in VRI Plan	
d) funding / funding submission	Proponent	
e) Undertake Inventory		
- TFL	Licensee	
- TSA	MOF	
f) warehousing products ("Custodianship")	Licensee/(MOF)	
2) Ecosystem and Habitat Mapping and Information Development		
a) Methods and Standards	MELP steward	
b) Inventory needs id and planning – Strategic	id in VRI Plan	
c) Inventory needs id and planning – Operational	id in VRI Plan	
d) funding submission (100% FRBC fundable)	Proponent:	
- TFL		
- TSA		
e) Undertake Inventory		
-TFLs	Licensee	MELP
-TSAs	MELP	MOF
f) Warehousing products ("Custodianship")	MELP custodian	
G. Land Integration Planning		
Management strategies and prescriptions	Licensee/MOF	MELP